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TO: ~~Joseph Wood~~, ESD/MICG (MD-13)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

FROM: Cybele Brockmann, Research Triangle Institute

SUBJECT: Final Summary of Emissions Test Data from Mississippi Lime's Ste. Genevieve Plant

REFERENCE: Information Gathering and Analysis for the Lime Manufacturing Industry NESHAP
EPA Contract 68-D1-0118
ESD Project 95/06
RTI Project 6750-017

This memo is a summary of emissions testing conducted in 1995 and 1997 at Mississippi Lime's plant in Ste. Genevieve, Missouri. The company submitted the 1995 data to EPA as a test report, which was enclosed with their questionnaire response.[1] The 1997 data was submitted to EPA as an excerpt from a test report.[2] Both sets of data were submitted as confidential business information (CBI). Because the summary of the emissions data in this memo does not reveal any production or process data, the memo is not being treated as CBI.

Four sources were tested in 1995; these included the exhaust from the coal and coke-fired rotary kiln # 6 after it passed through a baghouse; the exhaust from the coal and coke-fired rotary kiln # 10 after it passed through a venturi scrubber; the exhaust from the natural gas-fired vertical kiln # 5; and the exhaust from a natural gas-fired stone dryer after it passed through a baghouse. Based on design capacities reported in the plant's questionnaire, rotary kiln # 6, rotary kiln # 10, and rotary kiln # 5 were operating at 88 percent, 85 percent, and 113 percent of their design capacities, respectively, during testing.[3]

Two sources were tested in 1997; these included the exhaust from the coal and coke-fired rotary kiln # 10 after it passed through a venturi scrubber, and the exhaust from the coal and

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coke-fired rotary kiln # 8 after it passed through a venturi scrubber. Both kilns burn an 80/20 mixture of coal and coke, with coal being 80 percent of the fuel. Based on design capacities reported in the plant's questionnaire, rotary kiln # 10 and rotary kiln # 8 were operating at 94 percent and 95 percent of their design capacities, respectively, during testing.[4]

The 1995 testing included EPA Method 25A for measuring total hydrocarbons (THC); EPA Method 7E for measuring nitrogen oxides (NOx); EPA Method 6C for measuring sulfur dioxide (SO_2); EPA Method 10 for measuring carbon monoxide (CO); and EPA Method 201A for measuring particulate matter (PM). Method 201A determines PM from both the "front half" and "back half" of the sampling train. The PM data in this memo were calculated to represent PM collected only on the front half, i.e., on and upstream of the filter (equivalent to what is measured for EPA Method 5). The 1997 testing included EPA Method 26 A for measuring hydrogen chloride (HCl) emissions.

Summary of Data

Table 1 is a summary of emissions data as reported in the 1995 test report and the 1997 test report excerpt, and as calculated by RTI. The following are key points regarding this table:

- The test report and test report excerpt gave concentrations for gases in ppmvd and PM in gr/dscf at the percent oxygen in the stack. Except for rotary kiln # 6 (discussed below), the calculated concentrations are the reported concentrations adjusted to seven percent oxygen.

- The test report and test report excerpt gave mass emission rates in lb/hr and the average limestone feed rate for each kiln and stone dryer. Except for rotary kiln # 6, emissions in lb/ton of limestone (ls) were calculated by dividing the reported mass emission rate by the reported limestone feed rate. Note, limestone feed rates to the kiln and dryer are CBI, and thus are not shown in Table 1. Mass emission rates are also not shown in Table 1 to prevent calculation of limestone feed rates from lb/ton of limestone.

- The reported THC measurements are based on propane.

- The baghouse that controls the exhaust from rotary kiln # 6 has three stacks. Flow rate, concentrations, and mass emission rates were reported for each stack. The average concentration of a pollutant from all three stacks was calculated by taking a weighted average (based on flow rates) of the reported average concentration of the pollutant from each stack; this average was then adjusted to seven percent oxygen. The average lb/ton of ls of a pollutant from all three stacks was calculated by summing the reported average mass emission rate of the pollutant from each stack and then dividing by the reported limestone feed rate.

Table 2 is a summary of kiln emissions data from Mississippi Lime (as calculated by RTI in Table 1) and from previous testing by EPA and the National Lime Association (NLA); the EPA and NLA data are being shown for comparison purposes. The following are key points about this table.

- PM levels from five of the six controlled kilns (four with baghouses and one with a wet scrubber) ranged from 0.0039 to 0.484 lb/ton of ls; these levels are well below the 0.6 lb PM/ton ls limit set by the New Source Performance Standard for rotary kilns. The PM level from rotary kiln # 10, which is controlled by a venturi scrubber, was 0.62 lb/ton of ls. The PM level from the uncontrolled vertical kiln # 5 was 1.28 lb/ton of ls.

- The THC level from the uncontrolled vertical kiln # 5 was 63.8 ppmvd at seven percent oxygen (0.608 lb/ton of ls). THC levels from the controlled kilns ranged from 4.8 to 15 ppmvd at seven percent oxygen and from 0.02 to 0.059 lb/ton of ls.

- HCl emissions are shown for four rotary kilns; two fire coal and two fire an 80/20 mixture of coal/coke. Three of the kilns are controlled by wet scrubbers and one is controlled by a baghouse. HCl emissions from the three scrubbers ranged from 2.1 to 5 ppmvd at seven percent oxygen and from 0.017 to 0.028 lb/ton of ls. The HCl level from the baghouse was 103 ppmvd at seven percent oxygen (0.785 lb HCl/ton of ls).

- CO emissions from vertical kiln # 5 were substantially higher than CO emissions from rotary kilns # 10 and # 6 (3788.88 ppmvd at seven percent oxygen compared to 11.44 and 26.1 ppmvd at seven percent oxygen).

- NOx emissions from rotary kilns # 10 and 6 were substantially higher than NOx emissions from vertical kiln # 5 (353.87 and 511 ppmvd at seven percent oxygen compared to 17.79 ppmvd at seven percent oxygen).

Assessment of Data Quality for Mississippi Lime Data

For the 1995 data, the test report provided a discussion of how field and lab procedures were carried out. Based on this discussion, it appears that emissions data were collected and analyzed appropriately. However, the test report did not explain why vertical kiln # 5 had a measurement of 7 ppmvd at seven percent oxygen during run 1 compared to 3591.34 and 8194.62 ppmvd at seven percent oxygen for runs 2 and 3; the latter two data points are relatively high compared to CO measurements for the other kilns.

Because the 1997 data was provided as an excerpt, information was not available to assess data quality. In terms of the applicability of Method 26A for measuring HCl emissions, a recently completed study that compared the results of a draft test protocol using the gas filter correlation infrared (GFCIR) instrumental method (proposed EPA Method 322) and EPA Method 26 found that HCL measured by GFCIR was typically much higher than that measured by Method 26.[5] HCl emissions measured by EPA Method 26 may be underestimated by a factor of 2 to 25.[6] Subsequent laboratory recovery efficiency analyses suggested that Method 26 is biased significantly low due to a scrubbing effect in the front half of the sampling train. Therefore, it is possible that HCl emission data measured by EPA Method 26 may be underestimated.

Process Operations during testing at Mississippi Lime

The test report and test report excerpt did not provide a discussion of process operations during the 1995 and 1997 tests. However, as noted on page one of this memo, during both tests, all kilns were operating at production capacities greater than or equal to 85 percent of their reported design capacities.

Recommendations for Testing at Mississippi

Low HCl concentrations do not warrant testing at Mississippi Lime. Average THC concentrations may or may not warrant testing. Average THC concentrations at seven percent oxygen ranged from 12.85 to 63.8 ppmvd; however, at actual conditions (i.e., at 15.50 percent oxygen) these concentrations ranged from 10.83 to 24.8 ppmvd. If based on the latter, testing is not recommended.

References

1. Letter and attachment, J.S. Castleberry, Mississippi Lime Management Company, to J. Wood, EPA:MICG, November 3, 1995, enclosing response to NLA/EPA voluntary questionnaire for Mississippi Lime company (some data considered Confidential Business Information).

2. Letter and attachments, J. Castleberry, Mississippi Lime Company, to J. Wood, EPA:OAQPS:ESD:MICG, July 25, 1997, enclosing the report entitled, "Risk Associated with Hydrogen Chloride Emissions at Mississippi Lime of Mississippi Lime Company," and 1997 stack test data of HCl emissions from Mississippi Lime's Ste. Genevieve plant(Considered to be Confidential Business Information).

3. Letter and attachment, J.S. Castleberry, Mississippi Lime Management Company, to J. Wood, EPA:MICG, November 3, 1995, enclosing response to NLA/EPA voluntary questionnaire for Mississippi Lime Company (some data considered to be Confidential Business Information).

4. Reference 3.

5. Powell, J.H., Dithrich, E.C. Hot-Wet Instrumental Hydrogen Chloride Emissions Quantification Using GFCIR - Method Validation and Comparison. CPS Environmental Services and Portland Cement Association HPAS Task Force and Air Pollution Characterization and control, Ltd.

6. Reference 3.

Table 1. Summary of 1995 and 1997 Emissions Data as Reported in the Test Report and Test Report Excerpt and as Calculated by RTI

1995 Testing for PM, SO2, NOx, CO, and THC				Reported	Calculated	Calculated						
	Reported			gr PM/dscf	gr PM/dscf @ 7% O2	lb PM/ton LS	Calculated	Reported	Calculated	Calculated	Reported	Calculated
	% O2			front half only	front half only	front half only	lb SO2/ton LS	SO2 ppmvd	ppmvd SO2 @ 7% O2	lb NOx/ton LS	ppmvd	ppmvd NOx @ 7% O2
Run 1: outlet stack of vertical kiln #5	15.50			0.0144	0.037	0.446	0.00	0.00	0.00	0.355	13.75	35.39
Run 2: outlet stack of vertical kiln #5	15.00			0.0603	0.142	1.84	0.0272	0.77	1.81	0.127	5.00	11.78
Run 3: outlet stack of vertical kiln #5	16.00			0.0509	0.144	1.57	0.0136	0.38	1.08	0.051	1.98	5.62
Average of outlet stack of vertical kiln #5	15.50			0.0419	**0.108**	**1.28**	**0.0136**	0.38	**0.98**	**0.178**	6.910	**17.79**
Run 1: outlet stack of venturi on rotary kiln #10	6.00			0.1469	0.137	0.7717	0.018	2.95	2.75	1.3	295.45	275.62
Run 2: outlet stack of venturi on rotary kiln #10	6.00			0.1100	0.103	0.4658	0.031	6.20	5.78	1.5	431.8	402.8
Run 3: outlet stack of venturi on rotary kiln #10	5.50			0.1045	0.094	0.6227	0.062	9.0	8.12	2.1	423.45	382.20
Average of outlet stack of venturi on rotary kiln #10	5.83			0.1205	**0.111**	**0.62**	**0.037**	6.05	**5.58**	**1.6**	383.57	**353.87**
Run 1: outlet stack of baghouse on stone dryer	15.50			0.0112	0.0288	0.0433	0.00	0.00	0.00	0.04189	12.95	33.33
Run 2: outlet stack of baghouse on stone dryer	17.00			0.0089	0.0317	0.0346	0.00	0.00	0.00	0.05352	16.45	58.63
Run 3: outlet stack of baghouse on stone dryer	18.10			0.0139	0.0690	0.0537	0.006724	1.5	7.4	0.05849	17.55	87.12
Averge of outlet stack of baghouse on stone dryer	16.87			0.0113	**0.0389**	**0.04385**	**0.002241**	0.5	**2**	**0.05063**	15.65	**53.93**
		Calculated			Calculated				Calculated			Calculated
	Reported	weighted average	Reported	Reported	weighted average	Calculated	Calculated	Reported	weighted average	Calculated	Reported	weighted average
	% O2	% O2	dscfm	gr PM/dscf	gr PM/dscf @ 7% O2	lb PM/ton LS	lb SO2/ton LS	ppmvd SO2	ppmvd SO2 @ 7% O2	lb NOx/ton LS	ppmvd NO	ppmvd NOx @ 7% O2
Run 1: outlet stack #1 of baghouse on rotary kiln #6	14.00		25307.05	0.0359				0.00			220.00	
Run 4: outlet stack #1 of baghouse on rotary kiln #6	15.40		24483.82	0.0120				2.70			267.25	
Average of outlet stack #1 of baghouse on rotary kiln #6	14.70		24895.44	0.0240				1.35			243.63	
Run 2: outlet stack #2 of baghouse on rotary kiln #6	14.00		24681.67	0.0155				0.10			236.25	
Run 5: outlet stack #2 of baghouse on rotary kiln #6	14.80		24167.49	0.0160				1.73			198.25	
Average of outlet stack #2 of baghouse on rotary kiln #6	14.40		24424.58	0.0158				0.92			217.25	
Run 3: outlet stack #3 of baghouse on rotary kiln #6	15.20		24165.52	0.0096				0.20			202.00	
Run 6: outlet stack #3 of baghouse on rotary kiln #6	14.20		24011.96	0.0122				1.85			266.00	
Average of outlet stack #3 of baghouse on rotary kiln #6	14.70		24088.74	0.0109				1.03			234.00	
Weighted average of outlet stacks #1,2, and 3 of baghouse on rotary kiln #6		14.60			**0.0374**	**0.28**	**0.022**		**2.4**	**3.205**		**511**
1995 Testing for HCl[a]	Reported	Reported	Reported	Calculated	Calculated HCl							
	Stack Temp	% O2	ppmvd HCl	ppmvd HCl @ 7% O2	lb/ton ls							
Run 1: outlet stack of venturi on rotary kiln # 10	166 F	8.00	3.1	2.1	0.017							
Run 2: outlet stack of venturi on rotary kiln # 8	162 F	5.00	7.2	4.8	0.028							

[a]For the 1997 HCl data, one test run was conducted over the course of one hour; the one hour test time is accordance with Method 26A.

Table 1. Summary of 1995 and 1997 Emissions Data as Reported in the Test Report and Test Report Excerpt and as Calculated by RTI

1995 Testing for PM, SO2, NOx, CO, and THC							
	Calculated	Reported	Calculated	Calculated	Reported	Calculated	
	lb CO/ton LS	CO ppmvd	ppmvd CO @ 7% O2	lb THC/ton LS	ppmvd THC	ppmvd THC @ 7% O2	
Run 1: outlet stack of vertical kiln #5	0.04	2.7	7.0	0.347	14.05	36.17	
Run 2: outlet stack of vertical kiln #5	23.6	1524.38	3591.34	0.522	21.50	50.65	
Run 3: outlet stack of vertical kiln #5	45.2	2888.75	8194.62	0.955	38.85	110.2	
Average of outlet stack of vertical kiln #5	**22.9**	1471.94	**3788.88**	**0.608**	24.8	**63.8**	
Run 1: outlet stack of venturi on rotary kiln #10	0.038	14.2	13.2	0.070	16.6	15.5	
Run 2: outlet stack of venturi on rotary kiln #10	0.014	6.45	6.02	0.030	8.75	8.16	
Run 3: outlet stack of venturi on rotary kiln #10	0.050	16.55	14.94	0.078	16.45	14.85	
Average of outlet stack of venturi on rotary kiln #10	**0.034**	12.40	**11.44**	**0.059**	13.93	**12.85**	
Run 1: outlet stack of baghouse on stone dryer	0.01418	7.20	18.5	0.04285	13.85	35.65	
Run 2: outlet stack of baghouse on stone dryer	0.01337	6.75	24.1	0.04933	15.85	56.49	
Run 3: outlet stack of baghouse on stone dryer	0.01019	5.20	25.8	0.008621	2.8	14	
Averge of outlet stack of baghouse on stone dryer	**0.01258**	6.38	**22.0**	**0.03360**	10.83	**37.32**	
			Calculated			Calculated	
	Calculated	Reported	weighted average	Calculated	Reported	weighted average	
	lb CO/ton LS	ppmvd CO	ppmvd CO @ 7% O2	lb THC/ton LS	ppmvd THC	ppmvd THC @ 7% O2	
Run 1: outlet stack #1 of baghouse on rotary kiln #6		5.75			4.00		
Run 4: outlet stack #1 of baghouse on rotary kiln #6		16.55			3.80		
Average of outlet stack #1 of baghouse on rotary kiln #6		11.15			3.90		
Run 2: outlet stack #2 of baghouse on rotary kiln #6		8.65			2.60		
Run 5: outlet stack #2 of baghouse on rotary kiln #6		15.05			3.25		
Average of outlet stack #2 of baghouse on rotary kiln #6		11.85			2.93		
Run 3: outlet stack #3 of baghouse on rotary kiln #6		10.85			6.00		
Run 6: outlet stack #3 of baghouse on rotary kiln #6		14.30			1.50		
Average of outlet stack #3 of baghouse on rotary kiln #6		12.58			3.75		
Weighted average of outlet stacks #1,2, and 3 of baghouse on rotary kiln #6	**0.100**		**26.1**	**0.047**		**7.8**	

Table 2. Summary of 1995 and 1997 Mississippi Lime Emissions Data and Other Emissions Data

	Calculated gr PM/dscf @ 7% O2	Calculated lb PM/ton LS	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated HCl
1995 Mississippi Lime Test Data	front half only	front half only	lb SO2/ton LS	pprnvd SO2 @ 7% O2	lb NOx/ton LS	ppmvd NOx @ 7% O	lb CO/ton LS	ppmvd CO @ 7% O2	lb THC/ton LS	ppmvd THC @ 7% O2	ppmvd HCl @ 7% O2	lb/ton ls
Outlet stack of gas-fired vertical kiln #5	**0.108**	**1.28**	**0.0136**	**0.98**	**0.178**	**17.79**	**22.9**	**3788.88**	**0.608**	**63.8**		
Outlet stack of venturi on coal/coke-fired rotary kiln #10	**0.111**	**0.62**	**0.037**	**5.58**	**1.6**	**353.87**	**0.034**	**11.44**	**0.059**	**12.85**		
Outlet stacks of baghouse on coal/coke-fired rotary kiln #6	**0.0374**	**0.28**	**0.022**	**2.4**	**3.205**	**511**	**0.100**	**26.1**	**0.047**	**7.8**		
1997 Mississippi Lime Test Data												
Outlet stack of venturi on coal/coke-fired rotary kiln #10											**2.1**	**0.017**
Outlet stack of venturi on coal/coke-fired rotary kiln #8											**4.8**	**0.028**
1996 National Lime Association Test Data from Graybec[1]												
Outlet stack of baghouse on double-column natural gas-fired vertical kiln	**0.0008**	**0.0039**	*	*					**0.02**	**15.0**	*	*
Outlet stack of baghouse on coal/coke-fired rotary kiln	**0.0071**	**0.06**	**0.35**	**38.1**					*	*	*	*
1996 EPA Test Data from Eastern Ridge Lime and APG Lime[2]												
Outlet stack of wet scrubber on coal-fired rotary kiln	**0.0482**	**0.484**	**0.0493**	**7**					**0.0429**	**5.4**	**5**	**0.02**
Outlet stack of baghouse on coal-fired rotary kiln	**0.0312**	**0.342**	**1.29**	**97**					**0.042**	**4.8**	**103**	**0.785**

*Measurements for each of these gases were taken over the course of 4 runs; measurements during some of the runs contained non-detect values. The detection limit was not reported, thus averages of the four runs could not be computed.

References

1. Letter and attachment, A. Seeger, National Lime Association, to J. Wood, EPA:OAQPS:ESD:MICG, February 26, 1997, enclosing emission test report for test at two lime kilns at Graybec Calc, Incorporated, in Marbleton, Quebec.
2. Memorandum, C. Brockmann, RTI, to J. Wood, EPA:OAQPS:ESD:MICG, April 2, 1997, Non-CBI summary of draft results of emissions testing at APG Lime Company and Eastern Ridge Lime Company.